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To Mr. H. Steckley
Manager, Civil Works
Thermal and Hydraulic Generation Div

Attn: Mr. G.F. Smith

AUBURN TS SETTLEMENT INVESTIGATION

C.B.H. Cragg

Auburn TS has experienced structural distress in recent years due to settlement. This report describes a borehole and test pit subsoil investigation performed next to this brick building.

1.0 INTRODUCTION

Auburn TS is a brick structure constructed about 1911 to house indoor-type transformers. The TS is located in the north end of Peterborough beside Auburn GS on the Otonabee River. It is suspected that a logging operation and saw mill occupied the site prior to the present generating station. The previous ground level was several feet above the current TS floor level, according to old drawings (Dwg No 111-S-1445/1370).

The TS building and some structures in the switchyard north of the building have settled up to 2 inches (differentially). This has caused distress in the TS brickwork and leaks in the roof, endangering the transformers. Distress is most severe near the northwest corner of the TS building.

Due to the age of the structure, no subsurface information was available. The following soil investigation was done to find why the settlement had occurred and if more could be expected.

2.0 FIELD PROGRAM

Four boreholes and three test pits were excavated near the TS structure at the locations shown in Figure 1. All boreholes were sampled by split spoon at 2-1/2 foot depth intervals. Drilling of Boreholes 3 and 4 was halted by boulders. Dynamic cones were driven next to these borehole locations. Bedrock was cored at the Borehole 2 location.

Test pit #1 was hand dug in the switchyard. Test pits #2 and #3 were dug by backhoe. Proximity to overhead lines necessitated an outage for Borehole 3. An access ramp was also constructed to drill this location. Electrical clearances, ramp building and test pit excavation was arranged by personnel from Eastern Region.

Survey measurements were made of the TS building to assess settlement. Borehole elevations were tied by survey to the Otonabee River survey datum.

3.0 INVESTIGATION RESULTS

The borehole data is given in detail on Figures 2 to 5. Interpreted subsoil cross-sections summarize this data in Figures 6 and 7. Figure 8 gives the building survey results.

3.1 Building Settlement

Level surveys taken on . , of the concrete foundation wall show an elevation difference of 1.86 inches between the northwest and southwest building corners (Figure 8). Most of this elevation change takes place in the northern 1/3 of the building west wall. The same area exhibits the most severe structural distress. These elevations are exactly the same as measurements taken in 1982. Elevations taken along the north wall differ from the 1982 readings, possibly due to differences in measurement location.

This information suggests that settlement has halted, perhaps only temporarily.

3.2 Subsoil Conditions

Fill was found at ground surface in all borehole and test pit locations except north of the switchyard (Borehole 2). The fill contained a random assortment of large flat boulders, brick rubble, organic silt and sawdust. This material is generally in a loose state. Blow counts ranged from 4 to 60. The higher blow counts observed in some areas may be caused by striking rubble or brick in the borehole. Fill generally extended to a depth of 10 feet below grade. The fill is underlain by a thin layer of competent sand till and then shaley limestone bedrock. Grain size curves for the till are shown in Figure 9. A compact natural silt overlies the till at Borehole 2.

Sawdust was found in two locations: (1) Borehole 4 (near the southwest building corner) between depths of 5 ft and 6-1/2 ft below grade and (2) Test pit 3 (near the west wall stairs) for a depth of 3 feet below the building footings. While these are

significant thicknesses of sawdust, the areal extent of the sawdust appears to be quite limited. Boreholes and Test pits 6 to 10 feet away from these sawdust locations were free of sawdust. Ground water occurred at elevation 653 ±, covering some but not all of the foundation sawdust. While the sawdust did not appear visibly deteriorated, annual ground water fluctuation could be causing a slow decomposition of some of the sawdust. Since the sawdust is buried, the process of decomposition is retarded to such an extent that the seventy years taken to produce 2 inches settlement appears reasonable.

3.3 Foundations

As seen in Figure 8, the building foundation elevation is the same at Test pits 1 and 2. Foundation level is considerably higher at Test pit 3, where sawdust occurs. A thin covering of till-like material over the sawdust may have influenced this construction. There is no widening of the foundation wall where it bears on the soil.

4.0 SETTLEMENT CAUSES AND TREATMENT

Settlement of Auburn TS appears to result from the presence of loose fill containing sawdust, beneath the building foundations. Areas of the building where no major distress was observed exhibited higher fill densities (on the basis of blow counts) and had no sawdust below footing level.

Settlement due to decomposition of sawdust is consistent with the time span over which the settlement has occurred. Surveying, to third order accuracy, showed no perceptible settlement had occurred over the past 2 years. However, future settlement should be anticipated. As the settlement rate will depend on seasonal ground water changes and non cyclical environmental events, such as droughts, the settlement rate and total future amount cannot be predicted.

Three options are suggested for dealing with this situation:

(1) underpin the foundations - a reliable solution but expensive in these circumstances due to the depth of the footings (requiring shoring) and the proximity of switchyard structure footings.

(2) grouting the poor soil - not a reliable solution as the direction of grout penetration cannot be controlled or easily evaluated

(3) no foundation treatment - allow the building to settle, monitor distress every few years, repair roof with flexible membrane material to accommodate movements.

Due to the difficulty of foundation repairs and the slow rate of settlement, the no foundation treatment option is favoured.

5.0 SUMMARY

A soil investigation, consisting of 4 boreholes and 3 test pits, was performed at Auburn TS. A loose random fill, containing pockets of sawdust, was encountered overlying competent sand till and shaley limestone bedrock. Building settlements and resulting distress are attributed to a gradual decomposition of the sawdust. Future settlement rates and magnitude cannot be reliably estimated. Several treatment options were suggested.

Approved by:

T.W. Klym
Manager
Civil Research Department

Prepared by:

C.B.H. Cragg
Engineer
Soils Section

Reviewed by:

T.J. Carmichael
Supervising Engineer
Soils Section

CBHC:LM

TABLE I

Test Pit Summary

Test Pit 1	0' - 8'	FILL, rubble, sandy silt, loose footing depth 7'-7" below grade grade elevation ∿ 661.5'
Test Pit 2	0' - 7-1/2'	FILL, large flat stone, bricks, gravelly sand, trace sawdust (2' to 5')
	7-1/2' - 9-1/2'	TILL, grey, compact footing depth 5'-4" below grade grade elevation ∿ 660.0'
Test Pit 3	0 - 7-1/2'	FILL, large stones, sandy silt, rotted wood at 2', sawdust layer from 4-1/2' to 7-1/2' footing depth 4'-3" below grade grade elevation ∿ 661.2'

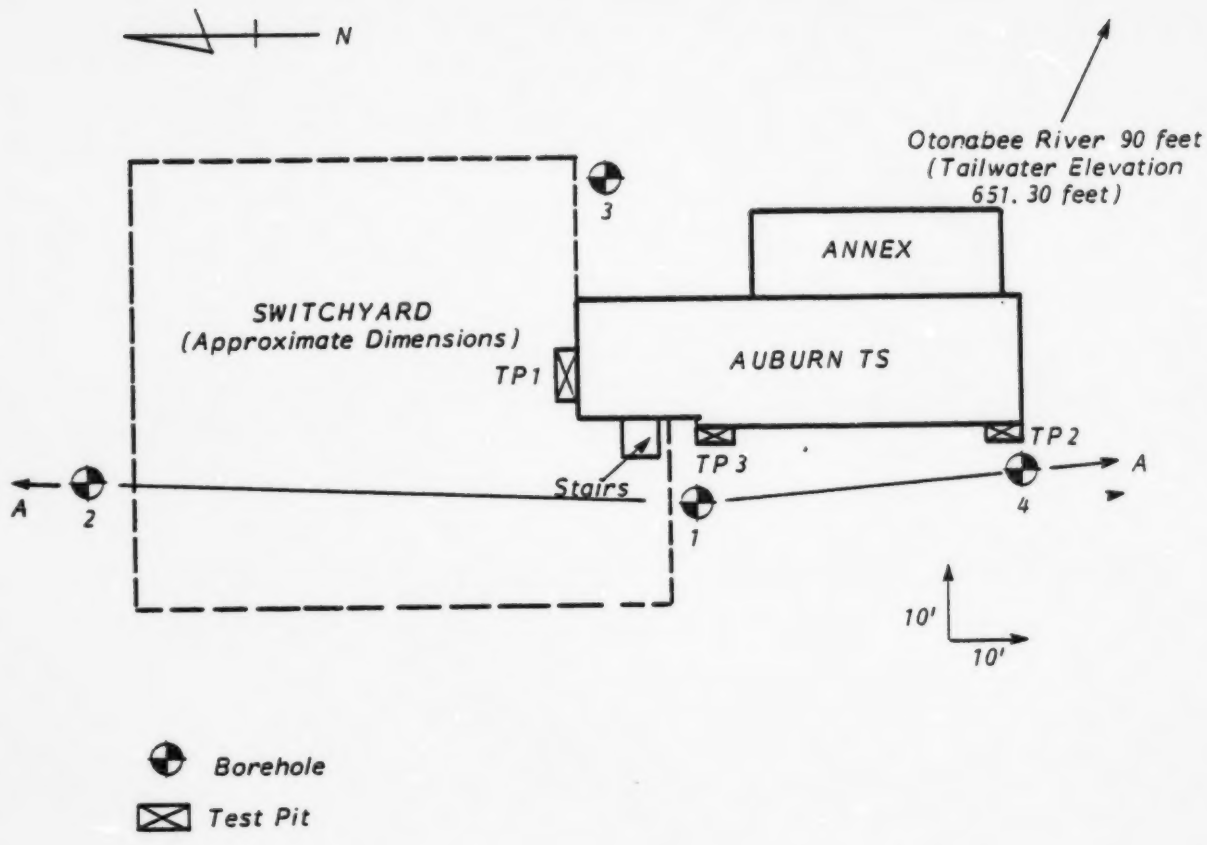


FIGURE 1

AUBURN TS
PLAN OF BOREHOLES

166868-RD

PROJECT AUBURN TS | HOLE TYPE SOLID AUGER | OBSERVER RVD

LOCATION SEE FIGURE 1 (NEAR NW STEPS) | HOLE SIZE 8" | COMPILED CBC

DIP | DRILLED AUGUST 22/84 | CHECKED

DATUM 661.2 ft | BEARING | DRAWN | APPROVED

SCALE - Feet	ELEV / DEPTH	SAMPLE NO.	SAMPLE TYPE	N VALUE per 0.3m / RQD-%	WATER LEVEL and CAVING / W.R.	DESCRIPTION	REMARKS	OBSERVATION WELL DATA	WATER PRESS. TEST	FIELD TESTS: SPECIAL TESTS TYPE	FIELD TESTS: SPECIAL TESTS RESULTS	NATURAL DENSITY kg/m³	MOISTURE CONTENT %	LABORATORY TESTS: SHEAR STRENGTH kPa TYPE	SHEAR STRENGTH kPa RESULTS	LABORATORY TESTS: SPECIAL TESTS TYPE	SPECIAL TESTS RESULTS
1						FILL, CRUSHED STONE											
						1.0'											
2						FILL, SILTY SAND, FINE TO COARSE, NUMEROUS PIECES OF RUBBLE (ROCK, CONCRETE AND BRICK) LOOSE, DARK GREY										
3		1A		50/6"									7.6				
4																	
5		2A		14									5.8				
6																	
7																	
8		3A		8									29.6				
9																	
10					▽	10.0'											
11		4A		39		SAND (TILL), SOME GRAVEL AND SILT, WELL GRADED, DENSE TO VERY DENSE, BROWN							12.3				
12																	
13		5A		100									9.4				
14						14.0'											
15						WEATHERED BEDROCK (ASSUMED)												
16																	
17						17.0'											
						END OF BOREHOLE AUGER REFUSAL ON APPARENT BEDROCK											

AUBURN TS | GEOTECHNICAL DATA SHEET | hole no 1 | Fig 2 | sheet 1 OF 1

200341-RD

PROJECT AUBURN TS — HOLE TYPE SOLID AUGER — OBSERVER RVD

LOCATION SEE FIGURE 1 (NORTH OF SWITCHYARD) — HOLE SIZE 4" — COMPILED CBC

DIP — DRILLED AUG 22/84 — CHECKED

DATUM 662.8' — BEARING — DRAWN — APPROVED

BORING DATA						BORING LOG		WATER INF.		FIELD TESTS		LABORATORY TESTS				
SCALE - Feet	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / RQD-%	(4) WATER LEVEL and CAVING / W.R.	(5) DESCRIPTION	(6) REMARKS	OBSERVATION WELL DATA	(8) k cm/s / WATER PRESS. TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS	NATURAL DENSITY kg/m³	MOISTURE CONTENT - %	(10) SHEAR STRENGTH kPa TYPE	(10) SHEAR STRENGTH kPa RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
1						SILT, SOME SAND, LITTLE GRAVEL, COMPACT, BROWN											
2																	
3		1A		12									18.0				
4																	
5	5.0'																
6		2A		60		SAND (TILL), SOME GRAVEL AND SILT, WELL GRADED, VERY DENSE, BROWN							4.8				
7																	
8		3A		68									7.7				
9																	
10																	
11		4A		63/9"	▽								12.0				
12	12.5'																
13						WEATHERED BEDROCK (ASSUMED)												
14																	
15																	
16																	
17	17.0' (AUGER REFUSAL)																
18						BEDROCK, SHALEY LIME-STONE, FREQUENT FRACTURES AND JOINTS, 90% CORE RECOVERY, POOR QUALITY												
19																	
20		BX		0%													
21																	
22	22.0'																
						END OF BOREHOLE											

AUBURN TS — GEOTECHNICAL DATA SHEET — hole no 2 — Fig 3 — sheet 1 OF 1

200342-RD

PROJECT ... AUBURN TS ... HOLE TYPE .. SOLID AUGER .. OBSERVER .. RVD ...

LOCATION .. SEE FIGURE 1 (NORTH EAST BLDG CORNER) .. HOLE SIZE .. 4" .. COMPILED .. CBC ...

... DIP ... DRILLED ... AUGUST 23/84 .. CHECKED ...

DATUM ... 661.4' ... BEARING ... DRAWN ... APPROVED ...

BORING DATA						BORING LOG	WATER INF		FIELD TESTS		LABORATORY TESTS					
SCALE Feet	ELEV / DEPTH	SAMPLE NO	SAMPLE TYPE	N VALUE per 0.3m / RQD-%	WATER LEVEL and CAVING / W.R	DESCRIPTION / REMARKS	OBSERVATION WELL DATA	WATER PRESS. TEST / cm/s	SPECIAL TESTS TYPE	SPECIAL TESTS RESULTS	NATURAL DENSITY kg/m³	MOISTURE CONTENT %	SHEAR STRENGTH kPa TYPE	SHEAR STRENGTH kPa RESULTS	SPECIAL TESTS TYPE	SPECIAL TESTS RESULTS
1						FILL, SILTY SAND, OCCASIONAL COBBLE OR BOULDER, LOOSE, DARK GREY			DC	3						
2										5						
3		1A		5						5						
4										7		5.1				
5										10						
6		2A		60/6"		6.0'				10		5.2				
7						AUGER REFUSAL				15						
8						8.0'				15						
9						SAND (TILL) VERY DENSE (ASSUMED)				60						
10										60						
11										50						
12						12.5'				70						
13						END OF CONE HOLE				70/6"						

AUBURN TS | GEOTECHNICAL DATA SHEET | hole no 3 | Fig 4

sheet 1 OF 1

200343-RD

PROJECT... AUBURN TS ..... HOLE TYPE.. SOLID AUGER OBSERVER RVD .....

LOCATION... SEE FIGURE 1 (SOUTHWEST BLDG CORNER) HOLE SIZE .. 4" COMPILED CBC .....

..... DIP ..... DRILLED ... AUG. 22/84 CHECKED .....

DATUM .... 660.0' BEARING ... DRAWN ... APPROVED

BORING DATA						BORING LOG		WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE Feet	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) N VALUE per 0.3m / RQD - %	(4) WATER LEVEL and CAVING W.R.	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) k cm/s	(9) SPECIAL TESTS TYPE	RESULTS	NATURAL DENSITY kg/m³	MOISTURE CONTENT %	(10) SHEAR STRENGTH kPa TYPE	RESULTS	(11) SPECIAL TESTS TYPE	RESULTS
									WATER PRESS. TEST								
	1					FILL, SAND, SOME GRAVEL,				DC	-						
	2					LITTLE SILT, FREQUENT					2						
	3	1A		20		COBBLE SIZE RUBBLE,					13						
	4					POCKET OF SAWDUST (5-6½ ft.)					10						
	5					DARK GREY, LOOSE					10						
	6	2A		4							15						
											10						
	7					7.0'											
						AUGER REFUSAL					14						
	8					8.0'											
	9					TILL (ASSUMED FROM					27						
						CONE AND TEST PIT DATA)					26						
	10										100						
	11					11.5'					100/6"						
	12					END OF CONE HOLE											

AUBURN TS	GEOTECHNICAL DATA SHEET	hole no 4	Fig 5
		sheet 1 OF 1	

200344-RD

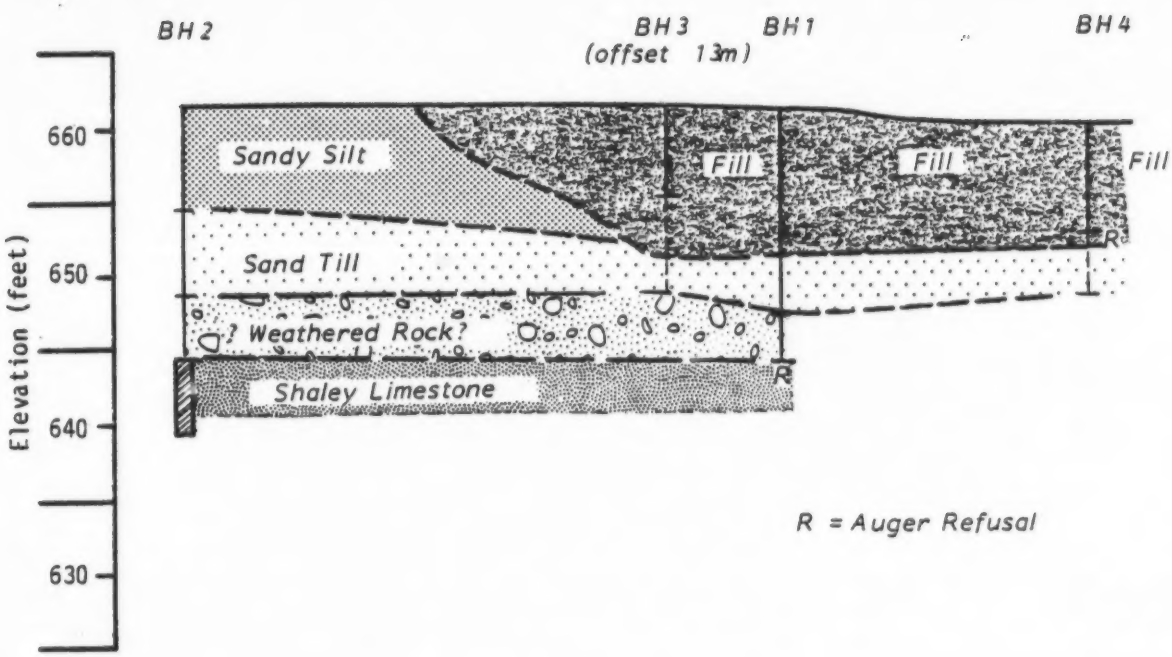


FIGURE 6

AUBURN TS
INTERPRETED SUBSOIL STRATIGRAPHY
AT SECTION A - A

166869-RD

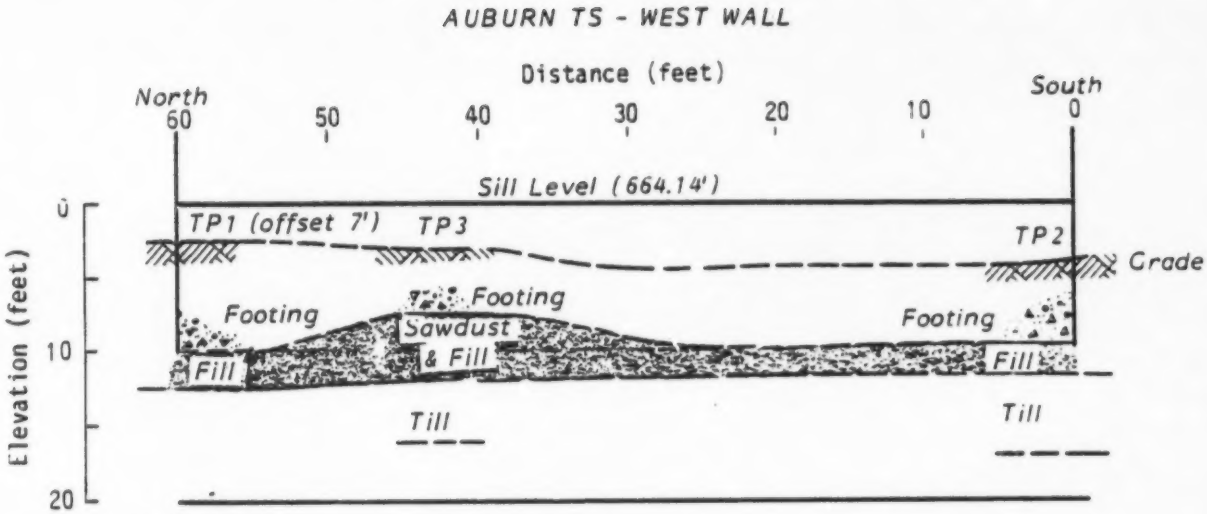
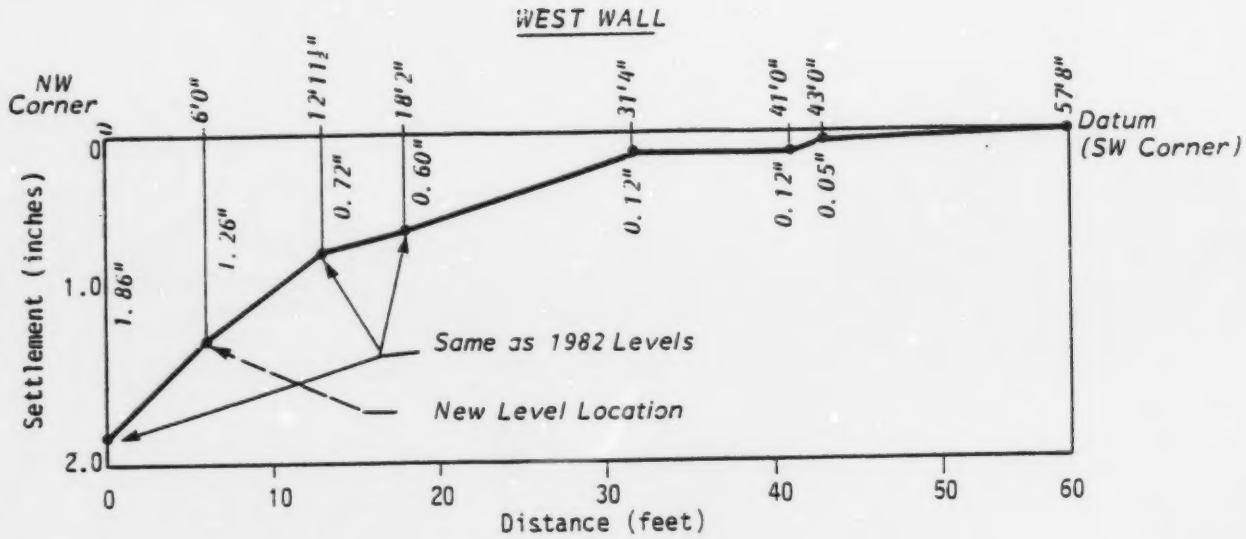


FIGURE 7

AUBURN TS
INTERPRETED SUBSOIL STRATIGRAPHY
AT TEST PIT LOCATIONS

166870-RD



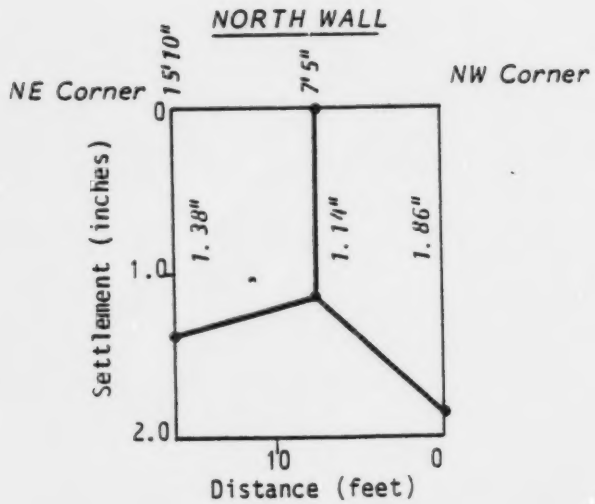
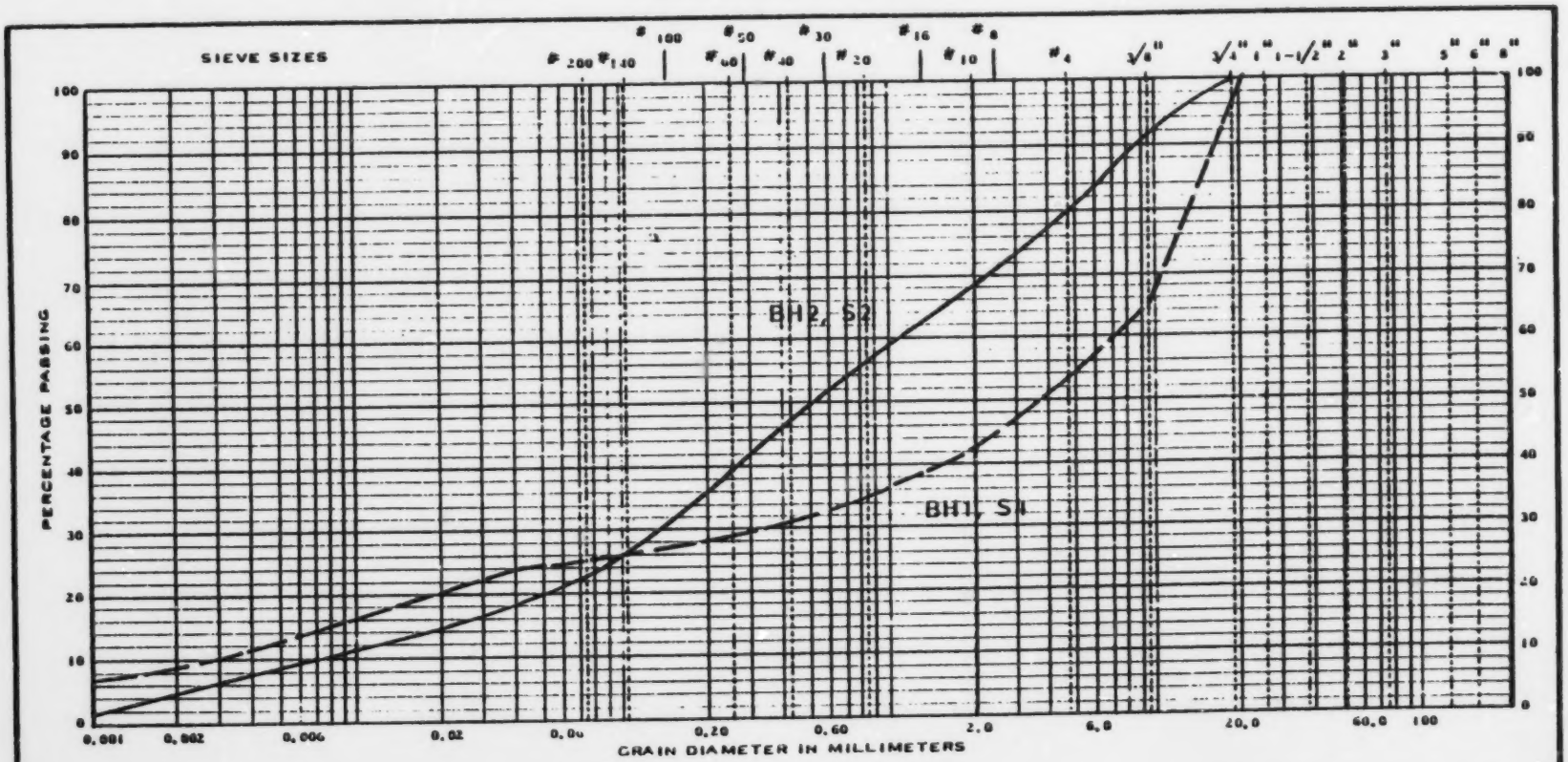


FIGURE 8

AUBURN T.S. FOUNDATION SURVEY
JULY 13, 1984

166871-RD

MECHANICAL ANALYSIS



CLAY TO SILT	SAND			GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	COARSE	

UNIFIED SOIL CLASSIFICATION

FIGURE 9

AUBURN TS - SAND TILL

THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO

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E-

166872-RD